Exploring the structure-properties relationship of novel polyamide thin film composite membranes

Briceno, Kelly; Javakhisvili, Irakli; Guo, Haofei; Fjerbæk Søtoft, Lene; Christensen, Knud Villy; Norddahl, Birgir; Hvilsted, Søren; Lipnizki, Frank

Publication date:
2015

Document version
Accepted author manuscript

Citation for pulished version (APA):
Briceno, K., Javakhisvili, I., Guo, H., Fjerbæk Søtoft, L., Christensen, K. V., Norddahl, B., ... Lipnizki, F. (2015). Exploring the structure-properties relationship of novel polyamide thin film composite membranes. Poster session presented at Euromembrane 2015, Aarchen, Germany.

Exploring the structure-properties relationships of novel polyamide thin film composite membranes

Euromembrane 2015

Kelly Briceño[1], Irakli Javakhisvili[2] , Haofei Guo[3] , Lene Søtoft[1] , Knud Villy Christensen[1] ,Birgir Norddahl[1], Søren Hvilsed[2], Frank Lipnizki[3]

(1) Department of Chemical Engineering, Biotechnology and Environmental Technology, University of Southern Denmark, Campusvej 55, 5230 Odense M, Denmark
(2) Danish Polymer Center, Department of Chemical and Biochemical Engineering, Technical University of Denmark, Building 227, 2800 Kongens Lyngby, Denmark
(3) R&D Department, Business Centre Membrane, Alfa Laval A/S, Stavangervej 10, 4900, Nakskov, Denmark
Corresponding author: kebr@kbm.sdu.dk

INTRODUCTION

Polysulfone (PSU) is a material widely used in the fabrication of membranes for ultrafiltration and as a support for nanofiltration and reverse osmosis membranes. Interfacial polymerization usually combines amine and acid chloride monomers for the fabrication of thin film composite membranes[1] . However, only few publications describe it's usage for the modification of supports for the fabrication of ultrafiltration membranes [2]. This research focuses on the modification of PSU supports to produce new ultrafiltration membranes.

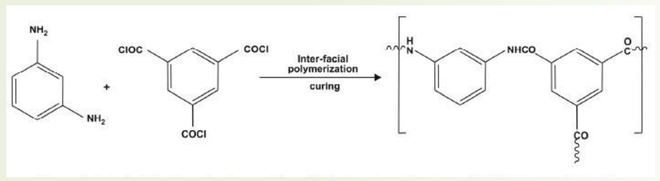

Fig 1. Interfacial polymerization of 1,3-phenylene diamine and 1,3,5-trimesoyl chloride

The advantages of interfacial polymerization in the fabrication of UF membranes includes:

- Negatively charged PSF surfaces that could be less prone to biofouling
- Scale up process for the modification of PSU. An alternative to costly and technically challenging processes as *in situ* interfacial polymerization [3].

THE MAIN CHALLENGE AND OBJECTIVE

- Determine the best amine and acid chloride combination to produce a defect free membranes accordingly to a fabrication procedure easy to scale up in the production line.
- Avoid traditional methods used in lab scale membrane fabrication in order to produce defect free membranes. It implies; analysis of support, type of monomers, concentration, reaction time and type of solvent [2]

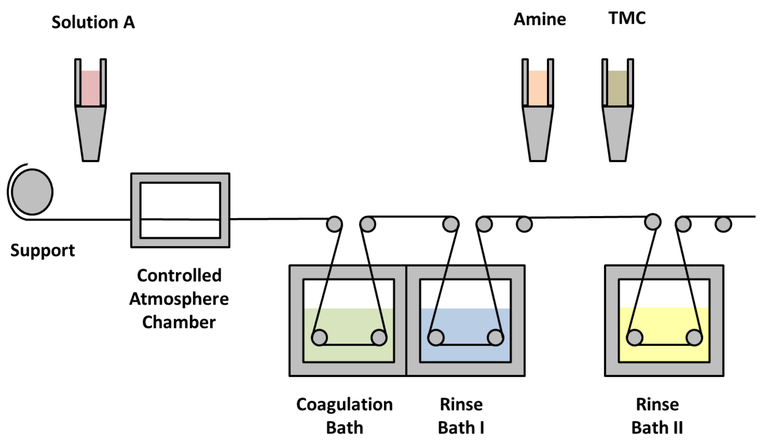

Fig 2. Industrial process for the fabrication of membranes by interfacial polymerization

- The membranes must be produced at lab scale emulating the fabrication in large scale.
- It is important to achieve a proper optimization of variables to reproduce defect free membranes at lab scale

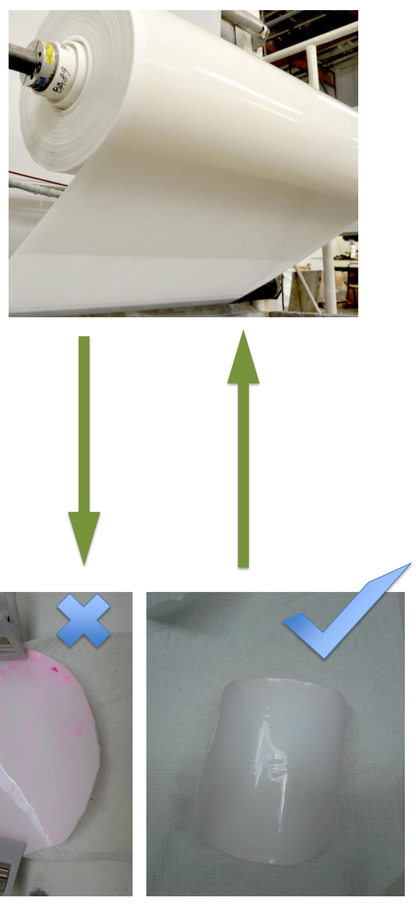

Fig 3. The presence of defects is verified with Rhodhamine B

CONCLUSIONS

- After screening different amine combinations it was possible to coat Polysulfone supports to produce membranes in the range of nanofiltration and ultrafiltration under interfacial polymerization conditions.
- Further optimization of the fabrication procedure is required to enhance water flux and improve antifouling properties in the ultrafiltration range.

THE METHOD

- More than 15 types of recipes have been tested in order to fabricate membranes with different fluxes.
- The membranes were fabricated in lab scale. Only immersion of the membrane film in different baths (no drain of excess solution [1] , no roller, air knife or oven) was used as intermediate steps/ tools
- Water flux was measured at 15.5 bar. The test membrane area was $4.5 \cdot 10^{-3}$ m^2

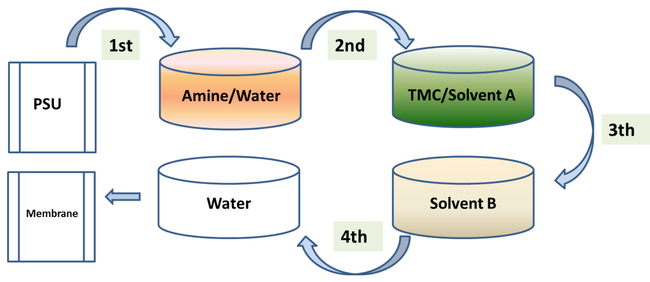

Fig 4. Fabrication method of thin film composite membranes

THE RESULTS

WATER FLUX OF DEFECT FREE MEMBRANES

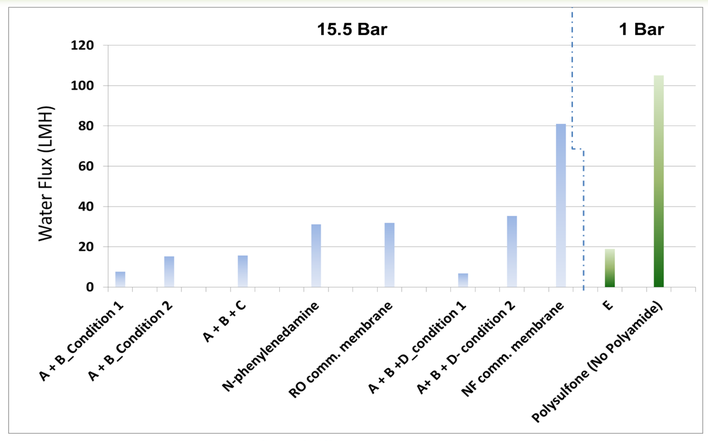

Fig 5. Water flux of different membrane recipes

Different combinations of monomers and fabrication variables produce different type of membranes. However, only a few recipes produced defect free membranes

MEMBRANE CHARACTERIZATION

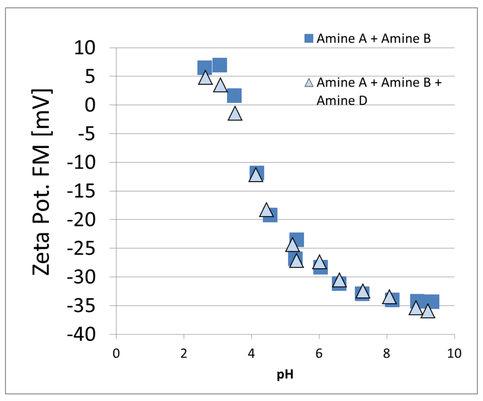

Fig 6. Zeta potential of 2 different recipes (10mM. M NaCl)

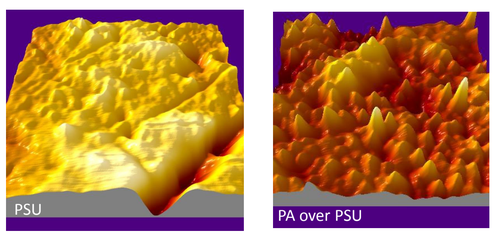

Fig 7. AFM images (3D) of PSF before and after coating with polyamide. Defect free membrane

Defect free membranes were achieved after parameter optimization. The high negative potential indicates a network structure with COOH pendant group.

REFERENCES

[1] Li Y, Su Y, Dong Y, Zhao X, Jiang Z, Zhang R, Zhao J, Separation performance of thin film composite membranes through interfacial polymerization using different amines monomers, Desalination 333 (2014), 59-65

[2] Mehrparvar A., Rahimpour A., Surface modification of novel polyether sulfone amide (PESA) ultrafiltration membranes by grafting hydrophilic monomer, Journal of Industrial and Engineering Chemistry, 2015

[3] Dong H-B; Xu Y-Y; Zhuan Yi; Shi J-L; Modification of Polysulfone membranes via surface-initiated atom transfer radical polymerization, Applied Surface Science 255 (2009), 8860-8866.

ACKNOWLEDGEMENTS

This research was supported by the Danish National Advance Technology Foundation.